

IN THE CLAIMS

Please amend Claims 1 and 5 as follows:

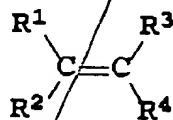
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--1. (Amended) A process of atom or group transfer radical polymerization, comprising the steps of:

polymerizing one or more radically polymerizable monomers in the presence of a catalyst system comprising an initiator having a radically transferable atom or group, a transition metal compound and a ligand, to form a copolymer, the transition metal compound being capable of participating in a redox cycle with the initiator and a dormant polymer chain, and the ligand being any N-, O-, P- or S- containing compound which can coordinate in a σ -bond to the transition metal or any carbon-containing compound which can coordinate in a π -bond to the transition metal, such that direct bonds between the transition metal and growing polymer radicals are not formed[, and

isolating the formed (co)polymer].

5. (Amended) The process of Claim 1, wherein said monomer(s) are of the formula:



wherein R¹ and R² are independently selected from the group consisting of H, halogen, CN, CF₃, straight or branched alkyl of from 1 to 20 carbon atoms, α,β -unsaturated straight or branched alkenyl or alkynyl of 2 to 10 carbon atoms, α,β -unsaturated straight or branched alkenyl of 2 to 6 carbon atoms substituted with a halogen, C₃-C₈ cycloalkyl, phenyl which may

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optionally have from 1 to 5 substituents on the phenyl ring selected from the group consisting of C₁₋₆-alkyl, C₁₋₆-alkenyl, C₁₋₆-alkynyl, C₁₋₆-alkoxy, halogen, nitro, carboxy, C₁₋₆-alkoxycarbonyl, hydroxy protected with a C₁₋₆-acyl, cyano and phenyl, heterocyclyl, C(=Y)R⁵, C(=Y)NR⁶R⁷ and YC(=Y)R⁸; where Y may be NR⁸ or O; R⁵ is alkyl of from 1 to 20 carbon atoms, alkoxy of from 1 to 20 carbon atoms, aryloxy or heterocycloxy; R⁶ and R⁷ are independently H or alkyl of from 1 to 20 carbon atoms, or R⁶ and R⁷ may be joined together to form an alkylene group of from 2 to 5 carbon atoms, thus forming a 3- to 6-membered ring; and R⁸ is H, straight or branched C₁-C₂₀ alkyl or aryl; and

R³ and R⁴ are independently selected from the group consisting of H, halogen, C₁-C₆ alkyl and COOR⁹, where R⁹ is H, an alkali metal or a C₁-C₆ alkyl group; or

R¹ and R³ may be joined to form a group of the formula (CH₂)_{n'} or a group of the formula C(=O)-Y-C(=O), where n' is from 2 to 6, the group (CH₂)_{n'} may be substituted with from 1 to 2n' halogen atoms or C₁-C₄ alkyl groups, and Y is as defined above; and

at least two of R¹, R², R³ and R⁴ are H or halogen.--

Claim 6, line 1, delete "initiators" and insert --initiator--.

SUPPORT FOR AMENDMENTS

Claims 1-25 are pending in this application. The above amendments to the claims and specification are supported by the claims as originally filed and the specification at page 19, lines 8-15. No new matter has been added by these amendments.

REQUEST FOR RECONSIDERATION

Applicants' representative would like to thank Examiner Cheng for the courteous and helpful discussion of the issues in the present application on February 6, 1997. The above amendments and following remarks summarize and further expand on the content of that discussion.

The present invention provides a method for the production of polymers by the use of a process dubbed by the present inventors as Atom (or group) Transfer Radical Polymerization, or ATRP for short. The process provides a controlled or "living" radical polymerization process that allows the production of polymers previously never achieved and a way to carefully control the molecular weight and/or distributions obtained in a radically prepared polymer, something basically unheard of prior to the present invention.

The present process comprises polymerizing one or more radically polymerizable monomers in the presence of a catalyst system comprising (i) an initiator having a radically transferable atom or group, (ii) a transition metal compound capable of participating in a redox cycle with the initiator and a dormant polymer chain, and (iii) a ligand that can coordinate to the transition metal in order to help prevent direct bonding between the transition metal and the growing polymer chain. One key to the present invention is the combination of the initiator having a radically transferable group or atom and the transition metal compound that

can participate in the redox cycle with that initiator and a dormant polymer chain. As shown in the specification at Figures 1 and 2, the present process provides a method for growing a polymer chain using a radically polymerizable monomer (not limited to just olefinically unsaturated monomers, but also including radical catalyzed ring opening polymerization also) which is controlled and provides extremely narrow molecular weight distributions when desired. This is analogous to the conventional anionic "living" polymerization that is well known in the art, but no one has ever been able to perform such controlled radical polymerizations prior to the present invention.

The present invention can use a wide variety of transition metals and transition metal compounds as discussed in the specification. Further a wide variety of initiators and ligands can also be accommodated. The chief requirement that must be met is that the metal must be able to perform in a redox cycle with the initiator and dormant monomer or polymer chains. The initiator must have at least one radically transferable atom or group. The phrase radically transferable atom or group includes a wide range of groups such as described beginning at page 19 of the specification. During the discussion of February 6, the Examiner expressed concern regarding the breadth of the current claims compared to the data provided in the specification. Applicants provide herewith a voluminous Declaration under 37 C.F.R. 1.132 that provides many examples of the present process using various metals, combinations of metals, various ligands, various monomers and various initiators in the preparation of homopolymers and copolymers of many morphologies. Surely the data provided in the specification combined with the data in the accompanying Declaration is more than enough to show that the present invention is of wide scope and entitled to a claim of correspondingly

broad scope. This is a breakthrough invention in the polymer sciences. As such a broad claim is due.

The claims stand rejected under 35 U.S.C. 103 over Harwood et al. Harwood et al disclose merely a conventional radical polymerization that cannot provide the type of controlled polymerization obtained in the present process. While it is true that Harwood et al disclose the use of Cu compounds as their so-called "catalyst", the Cu compound of Harwood et al is not acting as a catalyst but is merely a reagent in a conventional free radical initiating system. The initiators of Harwood et al are Cu complexes of enolates or carboxylates. Such compounds are not included within the scope of the present invention since they do not contain a radically transferable atom or group, which by definition in the present application must be reversibly transferable between an initiator and the transition metal and from the transition metal to the growing polymer chain, then from the polymer chain back to a molecule of the transition metal. As each addition of another monomer unit occurs in the present invention, the radically transferable group or atom must be able to move from the end of the growing polymer chain to the transition metal and then back onto the growing polymer chain having another monomer unit attached. The metal enolates/carboxylates of Harwood et al are not capable of such reactions and thus would not provide the type of polymerization seen in the present invention.

In fact, Harwood et al specifically teach away from the type of initiators used in the present invention. At column 5, lines 10-55, Harwood et al describe the difference between inner sphere and outer sphere redox systems, with their system noted as being outer-sphere redox. At lines 42-48, Harwood et al specifically state that inner-sphere ligand transfer, such as from metal halides, should be avoided due to the high susceptibility of free radical

polymerizations to inhibition by undesirable termination reactions. Applicants on the other hand have found that by using the present catalyst system requiring the appropriate types of initiator, metal and ligands, one can provide highly controlled free radical polymerization with rather astonishing results in terms of both the types of polymers made as well as the properties of those polymers, such as molecular weight control and distribution.

The initiating system of Harwood et al requires the abstraction of a hydrogen atom from the position adjacent a carbonyl group. Once this hydrogen abstraction has occurred the polymerization reaction then occurs with no control over termination or molecular weight or order of addition of monomers. The only way to provide a block copolymer using the method of Harwood et al is to perform a first polymerization, then go back and pluck off another hydrogen adjacent to a carbonyl in order to begin another polymerization chain. That is not the present invention. The present method provides polymers that have specified head groups (ie. the initiator) with specific tail groups (ie. the radically transferable atom or group). Further polymerization then requires only the addition of another batch of monomer in order to continue polymerizing from the same end of the polymer chain. The undesirable termination reactions seen in conventional radical polymerization such as Harwood et al, including disproportionation, hydrogen abstraction, etc. are virtually not seen, or at least minimal, in the present invention. Harwood et al cannot suggest such a process. As such the rejection over Harwood et al should be withdrawn.

With the submission of the present Rule 1.132 Declaration, Applicants have provided ample showing of the breadth of the present invention in support of the present claims. Unless the Examiner can provide a sound scientific reason that one of ordinary skill in the art would not expect the entire range of the claims to provide effectively the same process as explicitly

shown in the specification and accompanying Declaration, the full scope of the present claims should be allowed.

Applicants provide herewith an Information Disclosure Statement regarding the present application

Applicants submit that the application is now ready for examination on the merits, and early notification of such action is earnestly solicited.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.



Steven B. Kelber
Attorney of Record
Registration No. 30,073

J. Derek Mason, Ph.D.
Registration No. 35,270

Crystal Square Five - Fourth Floor
1755 Jefferson Davis Highway
Arlington, VA 22202
(703) 413-3000
Fax No.: (703) 413-2220
DJM/jot